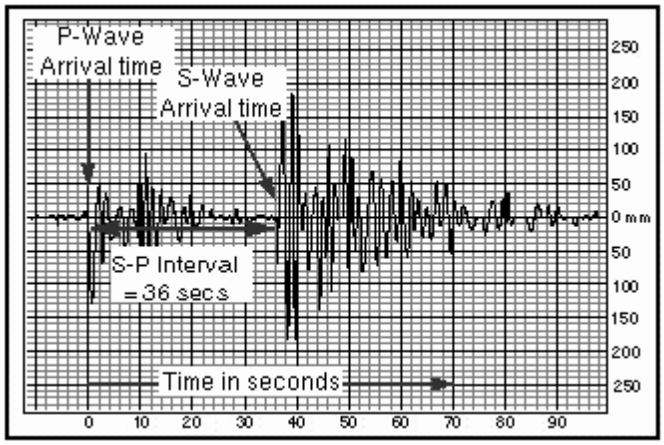
Name: _____

Locating an Earthquake and Determining Magnitude

What's a Seismogram?

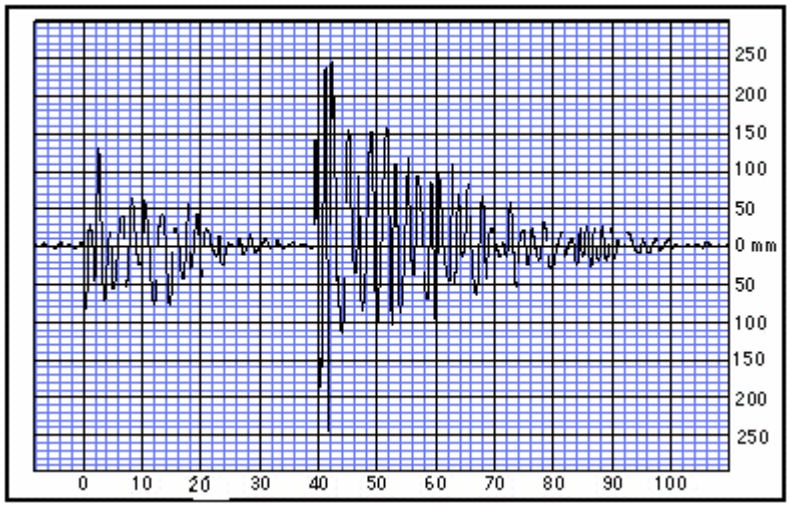
A highly simplified simulated recording of earthquake waves (a seismogram) can be seen to the right. Study this sample seismogram and be sure you can identify these parts:

P-wave and the P-wave arrival time
S-wave and the S-wave arrival time
S-P interval (expressed in seconds)
S-wave maximum amplitude (measured in mm from centerline)



(This exercise is based on the web page at http://vcourseware5.calstatela.edu/VirtualEarthquake)

Three Seismograms from Different Locations for the Same Earthquake
(Note: lines are 2 sec apart on the time scale and 10mm apart on the amp scale)



Las Vegas, NV.

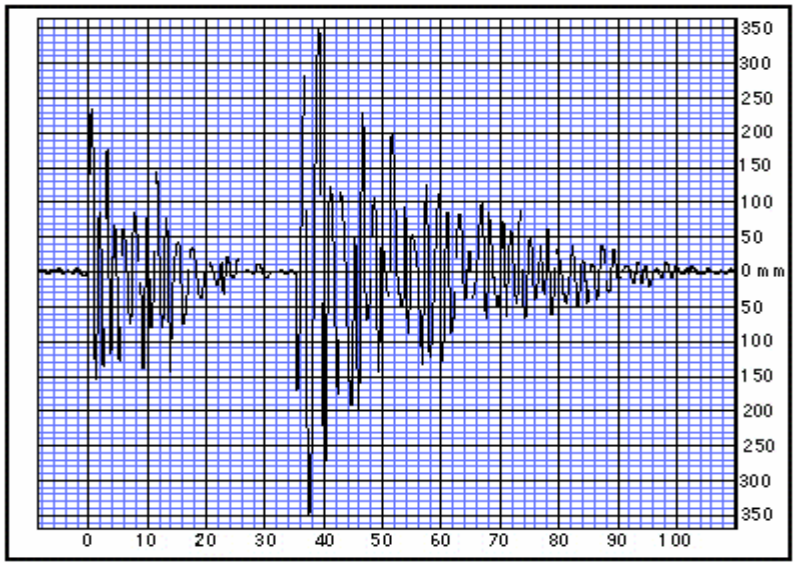
Measure the S-P time and amplitude & record them here:
S-P _____secs

Amplitude _____mm

Calculations (see next page):

Distance _____ km

Magnitude _____



Fresno, CA.

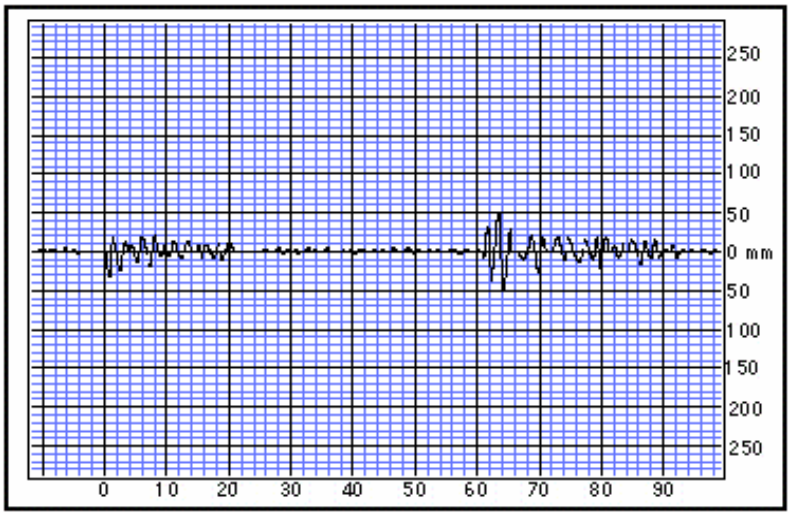
Measure the S-P time and amplitude & record them here:
S-P _____secs

Amplitude _____mm

Calculations (see next page):

Distance _____ km

Magnitude _____



Phoenix, AZ.

Measure the S-P time and amplitude & record them here:
S-P _____secs

Amplitude _____mm

Calculations (see next page):

Distance _____ km

Magnitude _____

Locating the earthquake (Step 1)

We know that P-waves travel about twice as fast as S-waves. We also know that for every second of S-P time the earthquake is about 8-10km (5-6 miles) away. For example, I f the S-P time is 60 seconds the earthquake is about 580 km away. Use this fact to calculate the DISTANCE from each station (city) to the earthquake's epicenter and write it in the *Calculations* section for each city on the previous page.

Locating the Earthquake (Step 2)

Now we are ready to locate the earthquake using a simple triangulation method.

Using the scale on the map (page 1), open your compass so it spans the distance from Las Vegas to the earthquake that you calculated in step 1. (Be sure you use the km scale and not the miles scale). If the distance is greater than the scale you must extrapolate. Now, draw a circle around Las Vegas with a radius of that distance.

Do the same for the other two cities. The circles should intersect at the epicenter of the earthquake.

Where was the earthquake? _____

Determining Local Magnitude

First, transfer the values for distance and amplitude from page 2 to the space below for each city. Next, use this "Richter scale" nomogram to determine the magnitude of the earthquake. For each city, place a ruler or piece of paper on the left-hand scale at the city's distance. Then shift the ruler up and down the right-hand scale until it is lined up with the amplitude value. Draw a line. Finally read the magnitude to the nearest 0.1 where the line crosses the center scale. To calculate a single magnitude value, average your three readings.

The "Richter Scale" (nomogram)

<u>Las Vegas, NV</u>

Dist = _____ Amp. =_____

Mag (M_L) = _____

<u>Fresno, CA.</u>

Dist = _____ Amp. =_____

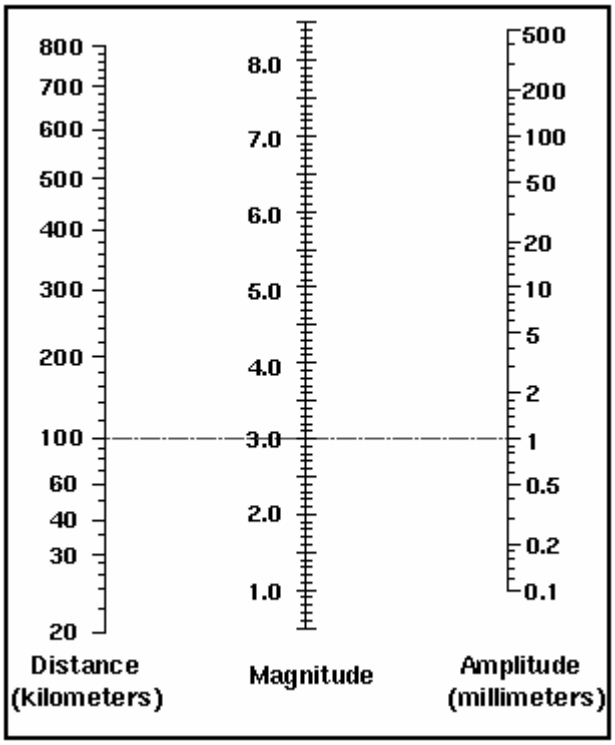
Mag (M_L) =_____

<u>Phoenix, AZ</u>

Dist = _____ Amp. =_____

Mag (M_L) =_____

Average mag = _____



The actual formula that this nomogram is based is: *Magnitude = log_{10}(amplitude) + distance correction*

Note that this is NOT the "Richter Magnitude". There is no such thing. You use the Richter scale to calculate the "local magnitude" or $\mathbf{M_L}$ of an earthquake. There are many types of magnitude besides "local magnitude". These are often used for very small events (<2.0) and very large events (>6.5).

Questions

Place your ruler on the 100km mark on the left side of the nomogram for these next questions. What would the amplitude be of an event of:

magnitude 3.0? _____ Of magnitude 4.0?_____ Of magnitude 5.0?_____

How would you summarize the relationship between amplitude and magnitude?

_____

_____

What happens to the amplitude as you get farther away from the epicenter? _____

_____

What is the minimum number of seismograms needed to locate an earthquake using this technique? _____

Why? _____

Often the circles don't intersect at a point. List as many reasons as you can for why this is so.

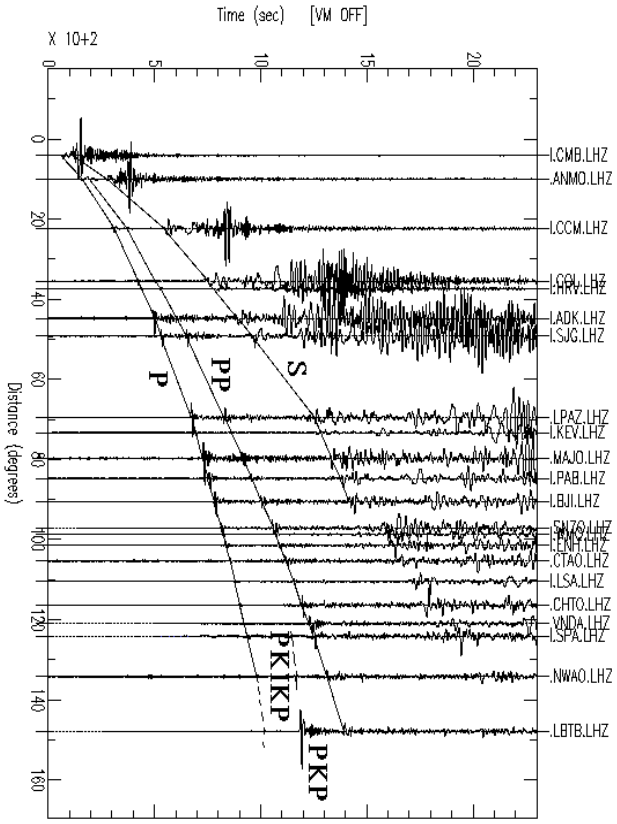
_____

_____

_____

_____

_____



Some real (more complicated) seismograms of this earthquake are shown to the left. They are plotted at increasing distance (in degrees) from the event. As the waves travel through the earth, P and S waves are reflected and refracted by various layers of the earth (such as the Moho or the core mantle boundary). This interaction produces additional seismic waves (phases) like echos that can also be detected by seismographs (e.g. PP, PKP, PKIKP)

Why is the line for the P and S arrivals curved?

_____

_____

What are the big waves that arrive after the S-waves?

_____